J. Plant Production, Mansoura Univ., Vol. 7(11): 1195 - 1200, 2016

Substantial Fluctuating of Nitrogen Sources and Levels for Improving Canola Productivity in New Reclaimed Lands

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ABSTRACT

In order to explore the effects of different sources and levels of nitrogen on agronomic characteristics of canola. Tow field experiments were conducted at the Experimental Farm, Faculty of Agriculture, Ismailia Governorate, Egypt during 2013/2014 and 2014/2015 seasons. Nitrogen fertilizer in the form of Ammonium Nitrate (AN) was added in two equal doses, the first dose, after three weeks of planting and the second one after seven weeks of planting at the levels of 0, 50,75 and 100 kg ha^{-1}. But nitrogen in the form of Ammonium Sulfate (AS) was practical in one equal portion after sowing and before irrigation at four levels, i.e. 0, 15, 30 and 45 kg ha^{-1}. Results designated that all agronomic characters increased with increasing N application, but the oil content diminished particularly with Ammonium Nitrate. Application of 100 kg N ha^{-1} in form of AN or 45 kg N ha^{-1} in form of AS chronicled the maximum seed yield in the two seasons. It could be determined that the cultivation of plants in the presence N in the form AN or AS enhanced the nutritional values of the yielded seed under the new reclaimed soils in Egypt.

Keywords: Canola, Nitrogen Sources and rates, Seed yield, Oil content.

INTRODUCTION

Canola (*Brassica napus* L.), sometimes known as oilseed rape, is an oilseed crop in the mustard or cabbage family, it is one of the most important oilseed crops in the world. It is widely refined throughout the world for the production of vegetable oil for human consumption and animal feed. In Egypt, oil crops occupy only about 1.83 % of the total cropped area (Abd El-Hady, 2004). Canola cultivation in Egypt may deliver an opportunity to overawe some of the deficiencies of edible oil production in Egypt. It could be positively grown during winter season in newly reclaimed soils of the Nile valley to get around the competition with other crops occupied the old cultivated area (Sharaan *et al*., 2002).

Nitrogen is obligatory in large amounts for crop growth and development, as it plays roles in plant tissue production, being present in proteins, amino acids, nucleotides, nucleic acids and chlorophyll. Nitrogen is one of the important factors as nutrient, which comprised about 50% of the dry matter of protoplasm in canola plant cells and is one of the essential elements for proper growth and development of the plant. Sharief and Keshta (2000) described that accumulative nitrogen fertilizer ranks up to 75 kg N/faddan significantly augmented 1000-seed weight, seed yield/faddan, seed and oil yields/faddan. Sharief *et al.* (2003) described that growing nitrogen fertilizer levels from 35 to 65 kg N/fed significantly increased seed yield/fed by 35.4 % and 35.7 % and increased oil yield/fed by 27.9 % and 28.2 % in the first and second seasons. Canola is very receptive to applications of N fertilizer, which has been shown to positively influence leaf area development, leaf area duration after flowering, branches per plant, flowers per plant and number and weight of pods and seeds per plant (Jackson, 2000). Canola seed and oil yields responded positively to the highest nitrogen level (60 kg fed^{-1}), while the maximum seed oil content was achieved when the lowest nitrogen level (30 kg fed^{-1}) was applied under sandy soils conditions (EL-Sarag, 2009). Öztürk (2010) stated that ammonium sulfate and urea gave a higher seed yield than ammonium nitrate. Results in both seasons indicated that 100 and 150 kg N ha^{-1} rate increased significantly yield and quality traits with regard to other N treatments. The present consequences highlight the practical importance of adequate N fertilization and true N source in seed yield in winter rapeseed and suggest that ammonium sulfate at 150 kg N ha^{-1} will be about adequate to meet crop N requirements. Ahmed (2011) indicated that nitrogen request better-quality seed number per silique and 1000-seed weight over two years. Oil percentage was decreased due to nitrogen and salinity in the first year. Salinity stress, increased glucosinolate and protein content. El-Habbasha and Taha (2011) strong-minded that the most effective treatment relating was Nitrobein + 60 kg N/fed, followed by the same level of nitrogen fertilizer with Azospirillium of most studied characters. Balanced and effective fertilizer management throughout the growing season is a vital part of any crop management strategy, having a large influence on sustaining soil productivity and optimizing crop yields and quality (Mohammadi *et al*., 2011). Osman *et al.* (2014) found the highest gained values for most characteristics of canola under investigation were accomplished when the plants received ammonium nitrate with the highest rate. Recently, El Sabagh *et al.* (2015) showed that chemical nitrogen significantly amended on yield parameters and the rate of 108 kg/ha produced the highest seed yield and yield traits. Consequently, the objective of this study was to explore the educating growth and productivity of canola in the reclaimed soils in Ismailia, Egypt by using different sources and levels of nitrogen.

MATERIALS

Two field experiments were conducted at the experimental farm, Faculty of Agriculture, Ismailia

Governorate (30° 35' 30" N, 32° 14' 50" E), Egypt during 2013/2014 and 2014/2015 seasons. Canola, cv. Serw 4 cultivar was cultivated on 21th October 2013/2014 and on 20th October 2014/2015. The soil mechanical and chemical analysis of the experimental site were shown in Table 1. investigation site was sandy soil (86.21% sand, 10.5 % silt and 3.29 clay) with pH 8.02 and EC 0.44 dsm^{-1}. Plants were thinned to two plants per hill, 20 cm apart.

Table 1. Soil mechanical and chemical analysis of the soil experimental site at Ismailia Governorate

Mechanical analysis (%)		Chemical analysis ($mg\ L^{-1}$) (1:5)						Available nutrients ($mg\ L^{-1}$ soil)	
		Parameters		Soluble Anions		Soluble Anions			
Sand	86.21	Organic matter (%)	0.19	Ca^{++}	0.82	$H\ CO3^{-1}$	3.66	N	7.8±1.3
Silt	10.5	$CaCO_3$ (%)	0.21	Mg^{++}	0.72	CL^{-}	1.36	P	13.2±1.1
Clay	3.29	pH (1:2.5)	8.03	K^{+}	0.30	$SO4^{--}$	0.04	K	7.6±1.5
Texture	Sandy	EC (dsm^{-1})	0.50	Na^{+}	1.77			S	29.4±1.5

METHODS

Tow field experiments were arranged using randomized complete block design with four replicates the two growing seasons. Recommended cultural and agronomic practices were adopted from sowing to harvest. No insecticide was sprayed in and around the experimental fields. Nitrogen fertilizer in the form of Ammonium nitrate (AN, 33.5% N) was added in two equal doses, the first dose, after three weeks of planting and the second one after seven weeks at the levels of 0, 50, 75 and 100 kg ha^{-1}. Nitrogen in the form Ammonium sulfate (AS) was applied in one equal portion; after sowing and before irrigation at four levels, *i.e.* 0, 15, 30, 45 kg ha^{-1}. At harvest time, one square meter was chosen randomly from the middle ridge of each plot in both seasons and some parameters were measured as follows:

1. Plant height (cm)
2. Number of branches/plant
3. Fruiting zone length (cm)
4. Seed yield/plant (g)
5. Seed yield (t ha-1): (3 inner ridges were harvested and weighted in kg m^{-2} then converted to ton ha^{-1})
6. Seed oil content: harvested plants were dried, threshed to determine seed oil percentage according to A.O.A.C (2000).

Statistical analysis: Data were statistically analyzed according to Sendecor and Cochran (1967). The proper statistical analysis of split–plot design was used. Differences among treatments were judged according to Duncan's multiple range test (Duncan, 1955). Means followed by different letters were statistically significant.

RESULTS

Effect of nitrogen sources and levels:

Ammonium nitrate (AN)

Nitrogen fertilizer levels in the Ammonium nitrate (AN) significantly exaggerated all agronomic characteristics in this study in both growing seasons 2013/2014 and 2014/2015. Results presented in Table 2 showed a significant and constant increase in means of canola yield, yield attributes and oil percentage by increasing nitrogen levels in both seasons. Increasing AN levels from 0 to 100 kg N ha^{-1} significantly increased plant height by 37.35 %, number of branches/ plant by 69.81%, fruiting zone by 40.88 %, seed yield/ plant by 38.28 % and seed yield/ha by 38.28 %. However, seed oil content was decreased by 7.52 % in 2013/2014 season. Meanwhile, increasing AN levels from 0 to kg 75 N ha^{-1} significantly increased plant height by 20.95 %, number of branches/plant by 30.18%, fruiting zone by 20.36%, seed yield/ plant by 18.15 % and seed yield/ha by 18.15 % but seed oil content decreased by 4.39% in the same growing season. On the other hand, increasing AN levels from 0 to 50 kg N ha^{-1} significantly increased plant height by 11.36 %, number of branches/ plant by 3.7 %, fruiting zone by 12.78 %, seed yield/plant by 14.19%, seed yield ha^{-1} by 14.19 % and seed oil content by 4.62 % during 2013/2014 season. In the second season, the same trend was obtained and the results showed that increasing AN levels from 0 to 100 kg N ha^{-1} significantly increased plant height by 39.1%, number of branches/plant by 72.54%, fruiting zone by 27.72 %, seed yield/plant by 39.39 % and seed yield/ha by 39%, while, seed oil content was declined by 7%. Temporarily, increasing AN levels from 0 to 75 kg N ha^{-1} significantly increased plant height by 21.5%, number of branches/plant by 29.41%, fruiting zone by 10.36 %, seed yield/plant by 22.55% and seed yield/ha by 22%. However, the seed oil percentage was reduced by 5 % in the same growing season. Cumulative ammonium nitrate levels from 0 to 50 kg N ha^{-1} significantly augmented plant height by 11.90 %, number of branches/plant by 15.68 %, fruiting zone by 3.51 %, seed yield/plant by 13.81% and seed yield/fed by 13.81%. However, seed oil content was decreased by 2.3 % in the same season. Nitrogen play roles in plant tissue production, being present in proteins, amino acids, nucleotides, nucleic acids and chlorophyll. These results are in harmony with those reported by Sharief and Keshta (2000); Öztürk (2010); El-Habbasha and Taha (2011) and Osman *et al.* (2014).

Ammonium sulfate (AS)

Results showed in Table 3 presented that canola yield, its attributes and oil percentage were highly significantly exaggerated by nitrogen levels in the form ammonium sulfate. Maximum values of plant height (167.3, 172.0 cm) were recorded with the application of 45 N kg ha^{-1} , while, the minimum ones (140.5, 139.1 cm) was observed in case of control treatment in 2013/2014 and 2014/2015 seasons. Similar trend was found for fruiting zone, where, the highest means (133.2, 130.6 cm) were recorded with the application of 45 kg N ha^{-1} but the ones (106.2, 108.2 cm) were observed in case of control treatment in both growing season. Adding 45 kg N ha^{-1} gave the maximum number of branches/plant (7, 7.1), while, the minimum numbers of branches/plant (5.4, 5.3) were produced in 0 kg N ha^{-1} in both growing seasons. Application of AS levels showed significant effect on seed yield per plant and hectare, where, the same trend was observed for 45 kg N ha^{-1} application which gave the maximum values (37.8, 38.7 g/plant, 2.177 and 2.229 t ha^{-1}) but control treatment (0 kg N ha^{-1}) produced the minimum values (30.2, 29.9 g/plant, 1.710, 1.722 t ha^{-1}) in 2013/2014 and 2014/2015 seasons.

Table 2. Effect of ammonium nitrate levels on yield, yield attributes and oil percentage of canola in 2013/2014 and 2014/2015 seasons

N-levels (kg ha^{-1})	Plant height (cm)	No. of branches	Fruiting zone (cm)	Seed yield/plant (g)	Seed yield (t ha^{-1})	Oil percentage %
2013/2014						
0	140.8 d	5.3 cd	110.3 d	30.3 c	1.745 c	42.19 b
50	156.8 c	6.1 b c	124.4 c	34.6 b	1.993 b	44.14 a
75	170.3 b	6.9 b	132.8 b	35.8 b	2.062 b	40.34 c
100	193.4 a	9.0 a	155.4 a	41.9 a	2.413 a	39.44 cd
F. test	**	*	**	**	**	*
2014/2015						
0	138.6 d	5.1 cd	119.4 d	29.7 d	1.710 d	42.48 a
50	155.1 c	5.9 b c	123.6 c	33.8 c	1.946 c	41.54 ab
75	168.4 b	6.6 b	132.1 b	36.4 b	2.096 b	40.43 b
100	192.8	8.8 a	152.5 a	41.4 a	2.384 a	39.52 b c
F. test	**	*	**	**	**	*

Values within column had the same letter are not significantly different

However, the highest oil percentages (43.0, 43.39%) were produced during treatment received 45 kg N ha^{-1}, while, the lowest ones (42.01, 41.82 %) were obtained during treatment received 0 kg N ha^{-1} in both growing seasons.

Table 3. Effect of ammonium sulfate levels on yield, yield attributes and oil percentage of canola in 2013/2014 and 2014/2015 seasons

N-levels (kg ha^{-1})	Plant height (cm)	No. of branches	Fruiting zone (cm)	Seed yield/plant (g)	Seed yield (t ha^{-1})	Oil percentage %
2013/2014						
0	140.5 b c	5.4 c	108.2 b c	30.2 cd	1.739 d	42.01 b
15	149.7 b	5.6 c	115.5 b	32.8 c	1.889 c	42.4 b
30	159.1 ab	6.3 b	120.8 b	34.7 b	1.998 b	42.9 a
45	167.3 a	7 a	130.6 a	37.8 a	2.177 a	43.0 a
F. test	*	*	*	**	**	*
2014/2015						
0	139.1 c	5.3 c	106.9 d	29.9 d	1.722 d	41.82 b
15	153.3 b	5.8 b c	117.9 c	33.4 c	1.923 c	42.2 b
30	161.1 ab	6.5 ab	124.9 b	35.9 b	2.067 b	43.2 a
45	172 a	7.1 a	133.2a	38.7 a	2.229 a	43.39
F. test	**	*	**	**	**	*

Values within column had the same letter are not significantly different

2.Correlation studies:

A positive and significant correlation was found among canola studied parameters under Ammonium nitrate and Ammonium sulfate with different levels (Table 4). All the correlation coefficients were positive and highly significant among all the studying parameters except seed oil percentage received AN levels (-0.891± 0.072, -0.273 ± -0.273) in the first and second seasons. R values were 0.977, 0.881, 0.956, 0.951 and 0.951 between nitrogen levels in form of AN and the studied agronomic parameters, i.e. plant height, number of branches, fruiting zone, seed yield per plant and seed yield per hectare, respectively, in 2013/2014 season. Meanwhile, these values of R increased to 0.984, 0.878, 0.965, 0.865 and 0.865 between nitrogen levels in form of AN and plant height, number of branches, fruiting zone, seed yield per plant and seed yield /ha, respectively, in 2014/2015 season. Also, R values were 0.999, 0.952, 0.986, 0.992, 0.992 and 0.942 between AS and plant height, number of branches, fruiting zone, seed yield per plant, seed yield/ha and oil content, respectively, in the first season. Meanwhile, plant height, number of branches, fruiting zone, seed yield per plant, seed yield/ha and oil content had highly positive correlation coefficients with AS different levels and all the studied parameters, where, their values were

0.984, 0.961, 0.991, 0.991, 0.973 and 0.936, respectively, in the second growing season. So, these highly positive correlated parameters could be important factors for improving canola seed yield and seed oil percentage under new reclaimed lands.

Table 4. Correlation coefficient among some canola characters under different nitrogen types and levels in 2013/2014 and 2014/2015 growing seasons.

Ammonium nitrate	**2013/2014**		**2014/2015**	
Parameters	R value ± SE	P (r = 0)	R value ± SE	P (r = 0)
Plant height (cm)	0.977 ± 0.033	0.0000 (***)	0.984 ± 0.021	0.0000 (***)
No. of branches	0.881± 0.076	0.0000 (***)	0.878 ± 0.032	0.0000 (***)
Fruiting zone (m)	0.958 ± 0.046	0.0000 (***)	0.965 ± 0.042	0.0000 (***)
Seed yield/plant	0.951± 0.049	0.0000 (***)	0.865 ± 0.035	0.0000 (***)
Seed yield/ha	0.951± 0.049	0.0000 (***)	0.865 ± 0.035	0.0000 (***)
Oil percentage (%)	-0.891± 0.072	0.0000 (***)	-0.273 ± 0.052	0.0877 (ns)
Ammonium sulfate				
Plant height (cm)	0.999 ± 0.021	0.0000 (***)	0.984 ± 0.042	0.0000 (***)
No. of branches	0.952 ± 0.032	0.0000 (***)	0.961± 0.066	0.0000 (***)
Fruiting zone (cm)	0.986 ± 0.042	0.0000 (***)	0.991± 0.046	0.0000 (***)
Seed yield/plant	0.992 ± 0.035	0.0000 (***)	0.991± 0.046	0.0000 (***)
Seed yield/ha	0.992 ± 0.035	0.0000 (***)	0.973± 0.038	0.0000 (***)
Oil percentage (%)	0.983 ± 0.052	0.0000 (***)	0.936 ± 0.068	0.0000 (***)

DISCUSSION

It is well known that canola has a much higher requirement for nutrients, especially nitrogen (N) in the form ammonium nitrate and ammonium sulfate compared to cereals such as wheat (Hopkins and Hünter, 2004). Optimum management of these nutrients may therefore be important to ensure high yielding canola crops, with high oil contents as well. The increases of nitrogen rates increased plant height, number of branches, fruiting zone, seed yield per plant and per hectare. Results may be attributed to the low soil content of available nitrogen, the role of nitrogen in stimulating the meristematic activity and cell elongation of plant which resulted in increasing photosynthesis activity of canola plant and associated with the increase in crop growth rate and reflected on the increases in seed yield and yield attributes. Nitrogen fertilizer source (AN & AS) is an important concept for maximizing canola yield, especially in new reclaimed lands which has low fertility level and low water holding. As for ammonium sulfate, which give acidic environment at microclimate around root zone in field research, it increases the availability of micro elements for the plant by reducing their dissolution in the soil (Kacar and Katkat, 2007). In this concern, Öztürk (2010) estimated that the positive effect of AS on seed yield of rapeseed comparing the other N sources (AN & Urea) may be associated with S content in AS. On the contrary, the decrease in seed oil percentage with increasing nitrogen rate was associated with the increase in protein synthesis in the seeds with increasing N levels which had negative correlation with fatty acids constitutions and reflected on seed oil percentage (EL-Sarag, 2009). Also, Kumar (2013) recorded that the application of 60 Kg Nitrogen/ha gave maximum seed yield of 3.8 t/ha. Imran (2014) mentioned that rapeseed cultivar positively responded for seed pod^{-1}, thousand seed weight (g), biological in yield/ha, seed yield/ha and oil yield in kg/ha to N levels. However, Rameeh (2015) displayed that nitrogen fertilizers gave substantial rapeseed yield increases even in diverse and contradicting conditions. It can be concluded that seed yield per hectare positively and significantly correlated with seed yield/ plant, plant height, number of branches and fruiting zone. Picking the correct dose, source and timing of N fertilizer application are an important aspect for successful canola productivity. Maximum yield at higher N levels than control might be due to the fact that all yield components, i.e., number of branches per plant, number of pods per plant, number of seeds per pod and 1000 seed weight, increased with increase in N (Rathke *et al.*, 2005). The problem of type of applied fertilizers, rarely taken into consideration by researches and in practice is even more ambiguous. In spite of the well-recognized effects of the main N fertilizer components, *i.e.* N sources and/ or some other nutrients as a secondary component as soil and plants, the third factor, i.e. chemical composition of the applied N fertilizers, is seldom treated as an important factor in the canola production. Ammonium nitrate had higher yield, yield components in the both seasons than ammonium sulfate. Since ammonium sulfate decreases pH, it leads to the dissolution of many micro elements and thus makes available for the plant. Ammonium sulfate contains sulfate dissimilar from other N sources. Results are analogous with (Tomer *et al*., 1997 and Öztürk, 2010) who reported that plant height, number of branches increased significantly with the increasing levels of ammonium sulfate fertilizers. The increases in seed yield per hectare with increasing nitrogen fertilizer level may be attributed to the low soil content of available nitrogen, the role of nitrogen in stimulating the meristic activity elongation of plant and increasing photosynthesis activity of oilseed plant associated with the increase in crop growth resulted in increases in seed yield per unit area and its attributes. These results in good accordance with those reported by Sharief *et al.*

(2003); EL-Sarag (2009); Ahmed (2011); Mohammadi *et al.* (2011) and El Sabagh *et al.* (2015). Also, the results are quite in line with the earlier research work done by Ali *et al*. (1996) who reported the maximum number of seeds/pod (31.19) at the high rate of Nitrogen and Sulphur against the lower rates of Sulphur application and control. The results are supported by Trividi and Singh (1999) who reported that increased levels of nitrogen and sulfur produced the highest 1000-seed weight. These results are in line with the findings of Khandkar *et al*. (1991) who reported that biological yield was maximum with increasing rates of nitrogen and Sulphur levels.

It could be concluded that nitrogen source and level as well are important factors for canola production under low nitrogen soil content. So, according to the present study, yield and yield attributes influenced by nitrogen fertilizer sources and levels, where, over the two growing seasons, 240 kg N ha^{-1} ammonium nitrate and/or 72 kg N ha^{-1} ammonium sulfate are the optimum nitrogen source and level for maximizing canola productivity in the new reclaimed lands and similar areas.

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إستمرارية مصادر التسميد النيتروجينى ومعدلاته على إنتاجية الكالنولا بالأراضى حديثة الإستصلاح

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أجريت تجربتان حقليتان بالمزرعة البحثية بكلية الزراعة – جامعة قناة السويس بمحافظة الإسماعيلية - مصر خلال موسمى ٢٠١٣/٢٠١٤، ٢٠١٤/٢٠١٥ بغرض دراسة مصادر التسميد النيتروجينى: نترات الأمونيوم بمعدلات صفر، ٥٠، ٧٥، ١٠٠ كجم/هكتار (سلفات الأمونيوم) بالمعدلات صفر، ١٥، ٣٠، ٤٥ كجم/هكتار وأثر ذلك على المحصول ومكوناته وتم تنفيذ التجارب فى تصميم القطاعات كاملة العشوائية فى أربع مكررات وتتلخص أهم النتائج فيما يلى:أوضحت النتائج أن زيادة معدلات التسميد النيتروجينى أدى إلى زيادة الصفات المحصولية ولكن إنخفض محتوى البذور من الزيت بالتسميد بسماد نترات الأمونيوم.أشارت النتائج إلى أن زيادة معدلات إضافة التسميد فى صورة سلفات الأمونيوم حتى ١٠٠ كجم/هكتار أو فى صورة نترات الأمونيوم حتى ٤٥ كجم/هكتار.توصى الدراسة بأن زيادة معدلات التسميد النيتروجينى إما فى صورة سلفات أو نترات الأمونيوم إلى زيادة كمية المحصول كماً ونوعاً تحت ظروف الأراضى الرملية حديثة الإستصلاح.